CLAIMS

What is claimed is:

1. A microelectronic spring contact element, comprising:

an elongate member of length "L" having a base end portion, a contact end portion opposite the base end portion, and a central body portion contiguous with each of the base and contact end portions;

the contact end portion is offset in a first direction from the central portion by a distance "d1";

the base end portion is offset in a second direction opposite the first direction from the central portion by a distance "d2";

wherein:

the base end portion is adapted in use to be mounted to a first electronic component; and

the tip end portion is adapted in use to make a pressure connection with a second electronic component.

2. A microelectronic spring contact element, according to claim 1, wherein:

the distance "d1" is in the range of 3-15 mils.

3. A microelectronic spring contact element, according to claim 2, wherein:

the distance "d1" is approximately 7 mils.

4. A microelectronic spring contact element, according to claim 1, wherein:

the distance "d2" is in the range of 0-15 mils.

5. A microelectronic spring contact element, according to claim 4, wherein:

the distance "d2" is approximately 7 mils.

6. A microelectronic spring contact element, according to claim 1, wherein:

the distance "d1" is in the range of <u>3-15</u> mils; and

the distance "d2" is in the range of <u>0-15</u> mils.

7. A microelectronic spring contact element, according to claim 1, wherein:

the spring contact element is thicker at the base end portion than at the contact end portion.

8. A microelectronic spring contact element, according to claim 1, wherein:

a thickness "t1" of the base end portion is in the range of <u>1-10 mils</u>.

9. A microelectronic spring contact element, according to claim 8, wherein:

the thickness "t1" of the base end portion is in the range of <u>2-5 mils</u>.

10. A microelectronic spring contact element, according to claim 1, wherein:

a thickness "t2" of the tip end portion is in the range of <u>1-10 mils</u>.

11. A microelectronic spring contact element, according to claim 10, wherein:

the thickness "t2" of the tip end portion is in the range of <u>1-5 mils</u>.

12. A microelectronic spring contact element according to claim 7, wherein:

the spring contact element has a thickness taper angle "ß" in the range of <u>0-30 degrees</u>.

13. A microelectronic spring contact element according to claim 12, wherein:

the spring contact element has a thickness taper angle "β" in the range of 0-6 degrees.

14. A microelectronic spring contact element, according to claim 1, wherein:

the spring contact element is **wider** at the base end portion than at the contact end portion.

15. A microelectronic spring contact element, according to claim 1, wherein:

the width "**w1**" of the base end portion is in the range of 3-20 mils.

16. A microelectronic spring contact element, according to claim 15, wherein:

the width "**w1**"of the base end portion is in the range of 8-12 mils.

17. A microelectronic spring contact element, according to claim 1, wherein:

the width "**w2**" of the tip end portion is in the range of 1-10 mils.

18. A microelectronic spring contact element, according to claim 17, wherein:

the width "**w2**" of the tip end portion is in the range of 2-8 mils.

19. A microelectronic spring contact element according to claim 14, wherein:

the spring contact element has a widthwise taper angle "α" in the range of 2-6 degrees.

20. A microelectronic spring contact element, according to claim 1, wherein:

the spring contact element is thicker at the base end portion than at the contact end portion;

the spring contact element is wider at the base end portion than at the contact end portion;

the spring contact element has a thickness taper angle "ß" in the range of 0-6 degrees.

; and

the spring contact element has a widthwise taper angle "α" in the range of 2-6 degrees.

21 A microelectronic spring contact element, according to claim 1, wherein:

the length "L" is in the range of 10-1000 mils.

22. A microelectronic spring contact element, according to claim 21, wherein:

the length "L" is in the range of 60-100 mils.

23. A microelectronic spring contact element, according to claim 1, wherein:

the elongate member has an overall height "**H**" which is the sum of "**d1**", "**d2**" and a thickness at the central body portion of the member; and

the overall height "H" is in the range of 4-40 mils.

24. A microelectronic spring contact element, according to claim 23, wherein:

the overall height "H" is in the range of 5-12 mils.

25. A microelectronic spring contact element, according to claim 1, wherein:

the elongate member has an overall height "**H**" which is the sum of "**d1**", "**d2**" and a thickness at the central body portion of the member; and

the length "**L**" is approximately at least FIVE times the overall height "**H**".

26. A microelectronic spring contact element, according to claim 1, wherein:

the elongate member has an overall height "**H**" which is the sum of "**d1**", "**d2**" and a thickness at the central body portion of the member; and

the distance "**d1**" is between one-fifth and one-half the size of the overall height "**H**".

27. A microelectronic spring contact element, according to claim 1, wherein:

the elongate member has an overall height "**H**" which is the sum of "**d1**", "**d2**" and a thickness at the central body portion of the member;

the member has a width "**w1**" at its base end portion;

the member has a width "**w2**" at its contact end portion; and

the width "**w2**" is between one-tenth and one-half the size of the overall height "**H**".

28. A microelectronic spring contact element, according to claim 1, wherein:

the contact end portion is provided with an integral protruding feature.

29. A microelectronic spring contact element, according to claim 28, wherein:

the integral protruding feature is in the form of a

pyramid or a truncated pyramid.

30. A microelectronic spring contact element, according to claim 28, wherein:

the integral protruding feature protrudes a distance "**d3**" from a surface of the contact end portion which is in the range of <u>0.25 - 5 mils</u>.

31. A microelectronic spring contact element, according to claim 30, wherein:

the distance "**d3**" is <u>3 mils</u>.

32. A microelectronic spring contact element, according to claim 1, further comprising:

a separate and distinct contact tip structure mounted to the contact end portion.

33. A microelectronic spring contact element, according to claim 32, wherein:

the contact tip structure has a different metallurgy than the spring contact element.

34. An electronic component, comprising:

an electronic component having a plurality of terminals on a surface thereof;

a plurality of elongate spring contact elements, each having a base end and a contact end opposite the base end, mounted by their base ends to the terminals, their contact ends extending above the surface of the electronic component to positions which are laterally offset from the respective base ends.

35. An electronic component, according to claim 34, further comprising:

cavities formed in the surface of the electronic

component extending from underneath the contact end of a corresponding spring contact element towards the base end of the spring contact element, said cavities allowing the contact ends to deflect below the surface of the electronic component.

36. An electronic component, according to claim 34, further comprising:

a rigid material disposed on the surface of the electronic component, said rigid material extending from the base end of a corresponding spring contact element partially along a central body portion of the spring contact element towards the contact end of the spring contact element.

37. An electronic component, according to claim 34, further comprising:

a material encapsulating a portion of the spring contact element including the base end and a contiguous portion of the central body portion thereof, the contact end and a contiguous adjacent remaining portion of the central body portion being free of material encapsulating the spring contact element.

38. Electronic interconnection apparatus, comprising:

a sacrificial substrate; and

a plurality of spring contact elements residing upon the sacrificial substrate;

wherein, in use, the spring contact elements can be mounted, en masse, to terminals of an electronic component.

39. Electronic interconnection apparatus, according to claim 38, wherein:

the sacrificial substrate is a material that matches the coefficient of thermal expansion of silicon.

40. Electronic interconnection apparatus, according to claim 38, wherein:

the sacrificial substrate is a material selected from the group consisting of silicon, aluminum, copper, ceramic, copper-invar-copper and aluminum-alumina-aluminum.

41. Electronic interconnection apparatus, according to claim 38, further comprising:

a release mechanism incorporated into the sacrificial substrate which, in use, permits the sacrificial substrate to be removed after the spring contact elements are mounted to the terminals of the electronic component.

42. Method of mounting a plurality of spring contact elements to terminals of an electronic component, comprising:

fabricating a plurality of spring contact elements upon a sacrificial substrate;

subsequently, while the spring contact elements are resident on the sacrificial substrate, mounting the spring contact elements to terminals of an electronic component; and

after the spring contact elements are mounted to the terminals of the electronic component, removing the sacrificial substrate.

43. Method, according to claim 42 wherein:

the electronic component is a space transformer.

44. A method of making a plurality of spring contact elements which are supported in a predefined spatial relationship with one another, comprising:

defining a plurality of trenches in a surface of a sacrificial substrate;

depositing at least one layer of a metallic material into the trenches, the metallic material in each trench representing a one of the plurality of spring contact elements;

wherein each spring contact element is elongate, and is formed to have a contact end portion that is deeper in the surface

of the sacrificial substrate than a central body portion of the contact element, thereby forming a first step between the contact end portion and the central body portion.

45. A method, according to claim 44, further comprising:

each trench comprises at least two contiguous subtrenches formed in the surface of the sacrificial substrate, a first one of the two subtrenches being at a first depth, a second one of the two subtrenches being at a second depth which is deeper than the first depth so that the resulting contact element has at least one step.

46. A method, according to claim 44, further comprising:

prior to depositing the at least one layer of metallic material, forming a depression adjacent an end of the trench.

47. A method, according to claim 44, further comprising:

after making the spring contact elements on the sacrificial substrate, mounting them to an electronic component, then removing the sacrificial substrate.

48. A method of mounting a plurality of spring contact elements to a microelectronic component, comprising:

providing a plurality of elongate spring contact elements, each having a base end, a contact end, and a central body portion therebetween; and

mounting the base ends of the spring contact elements to corresponding terminals on an electronic component, the contact ends of the contact elements extending above the surface of the electronic component.

49. Method, according to claim 48, wherein:

the electronic component is a space transformer of a probe card assembly.

50. Method, according to claim 48, wherein:

the electronic component is a semiconductor device.

51. Method of forming microelectronic spring contact elements on a silicon substrate, comprising:

providing a blanket layer of silicon nitride on a surface of a silicon substrate;

creating a plurality of openings through the silicon nitride layer, thereby exposing the surface of the silicon substrate;

etching the silicon substrate within the openings to form a corresponding plurality of first trenches, each extending to a first depth below the surface of the silicon substrate;

masking a portion of the first trenches;

etching the silicon substrate within an unmasked portion of the first trenches to form a corresponding plurality of second trenches each extending to a second depth, greater than the first depth, below the surface of the silicon substrate;

depositing metallic material into the first and second trenches, the metallic material deposited into each first trench and corresponding second trench serving as one of a plurality of resulting microelectronic spring contact elements.

52. Method, according to claim 51, further comprising:

when depositing the metallic material into the first and second trenches, depositing the metallic material onto a portion of the surface of the silicon substrate which is adjacent to and contiguous with the first trenches.

53. Method, according to claim 52, further comprising:

prior to depositing the metallic material, depositing a release layer into the first and second trenches and contiguous adjacent portion of the silicon substrate, said release layer adapted in use to permit the resulting microelectronic spring contact elements to be removed from the silicon substrate.